CLAIMS

1. Method for controlling a direct injection internal combustion engine operable in a homogenous region of operation generally associated with relatively high engine load/high engine speed operating conditions and a non-homogeneous region of operation generally associated with relatively low engine load/low engine speed operating conditions, said engine including a NOx trap generally effective to accumulate NOx emissions during lean operation of the engine and to release said accumulated NOx emissions during rich operation of the engine comprising:

providing a first region of homogeneous engine operation during periods of engine operation wherein the accumulated NOx emissions are below a first predetermined threshold; and,

providing a second region of homogeneous engine operation greater than said first region of homogeneous operation during periods of engine operation wherein the accumulated NOx emissions are not below said first predetermined threshold.

2. The method for controlling a direct injection internal combustion engine as claimed in claim 1 further comprising:

regenerating the NOx trap when the engine is operated in the second region of homogeneous operation.

3. The method for controlling a direct injection internal combustion engine as claimed in claim 1 further comprising:

regenerating the NOx trap upon the first to occur of a) NOx trap temperature exceeding a threshold temperature, b) the accumulated NOx emissions exceeding a second predetermined threshold greater than said first predetermined threshold, and c) the engine being operated in the second region of homogeneous operation.

4. The method for controlling a direct injection internal combustion engine as claimed in claim 2 wherein regenerating the NOx trap is

caused to occur as a function of the accumulated NOx emissions in the NOx trap.

5. The method for controlling a direct injection internal combustion engine as claimed in claim 4 further comprising:

terminating regeneration and resetting the accumulated NOx to the level of the remaining stored NOx in the lean NOx trap when a regeneration ending event is reached.

6. The method for controlling a direct injection internal combustion engine as claimed in claim 5 wherein said regeneration ending event is selected from the group consisting of rich deviation of gases flowing out of the NOx trap, expiration of a regeneration timer, and engine torque demand below a threshold value.

7. The method for controlling a direct injection internal combustion engine as claimed in claim 3 wherein regenerating the NOx trap is caused to occur as a function of the accumulated NOx emissions in the NOx trap.

8. The method for controlling a direct injection internal combustion engine as claimed in claim 7 further comprising:

terminating regeneration and resetting the accumulated NOx to the level of the remaining stored NOx in the lean NOx trap when a regeneration ending event is reached.

9. The method for controlling a direct injection internal combustion engine as claimed in claim 8 wherein said regeneration ending event is selected from the group consisting of rich deviation of gases flowing out of the NOx trap, expiration of a regeneration timer, and engine torque demand below a threshold value.

10. Method for controlling regeneration of a lean NOx trap comprising:

estimating an accumulated NOx in a NOx trap located in the exhaust path of an engine; and,

hastening regeneration of the NOx trap by reducing the size of a stratified charge operating region of the engine when the accumulated NOx exceeds a first threshold value and initiating regeneration when the stratified charge operating region of the engine is exited.

11. The method of claim 10, further comprising:

estimating the temperature of the NOx trap; and,

determining a desired air-fuel ratio for initiating regeneration of the NOx trap, the desired air-fuel ratio being determined based upon one or a combination of the estimated accumulated NOx stored within the NOx trap and the temperature of the NOx trap

12. The method of claim 11, further comprising:

determining whether the temperature of the NOx trap exceeds a threshold temperature;

determining whether the estimated NOx in the NOx trap exceeds a second threshold value greater than the first threshold value; and

initiating regeneration of the NOx trap when the estimated NOx in the NOx trap exceeds the second threshold value or when the estimated temperature of the NOx trap exceeds the threshold temperature by forcing homogenous operation of the engine at the desired air-fuel ratio.

13. The method of claim 10, further comprising:

ending regeneration and resetting the accumulated NOx to the level of the remaining stored NOx in the lean NOx trap when a regeneration ending event is reached.

14. The method of claim 13, further comprising:

monitoring exhaust gases flowing out of the NOx trap wherein the regeneration ending event is reached when the monitored exhaust gases flowing out of the lean NOx trap show a rich deviation.

15. The method of claim 13, further comprising:

monitoring the elapsed regeneration event time wherein the regeneration ending event is reached when the elapsed regeneration event time exceeds a target maximum regeneration event time interval.

16. The method of claim 13, further comprising:

monitoring driver torque demand on the engine wherein the regeneration ending event is reached when the driver torque demand drops below a threshold value.

17. The method of claim 13, wherein the regeneration ending event is triggered by a driver initiated action.

18. Article of manufacture comprising:

a storage medium having a computer program encoded therein for causing an engine controller to control a direct injection internal combustion engine operable in a homogenous region of operation generally associated with relatively high engine load/high engine speed operating conditions and a non-homogeneous region of operation generally associated with relatively low engine load/low engine speed operating conditions, said engine including a NOx trap generally effective to accumulate NOx emissions during lean operation of the engine and to release said accumulated NOx emissions during rich operation of the engine, said program including:

code for providing a first region of homogeneous engine operation during periods of engine operation wherein the accumulated NOx emissions are below a first predetermined threshold; and,

code for providing a second region of homogeneous engine operation greater than said first region of homogeneous operation during

periods of engine operation wherein the accumulated NOx emissions are not below said first predetermined threshold.

19. The article of manufacture as claimed in claim 18 further comprising:

code for regenerating the NOx trap when the engine is operated in the second region of homogeneous operation.

20. The article of manufacture as claimed in claim 18 further comprising:

code for regenerating the NOx trap upon the first to occur of a) NOx trap temperature exceeding a threshold temperature, b) the accumulated NOx emissions exceeding a second predetermined threshold greater than said first predetermined threshold, and c) the engine being operated in the second region of homogeneous operation.

21. The article of manufacture as claimed in claim 19 wherein regenerating the NOx trap is caused to occur as a function of the accumulated NOx emissions in the NOx trap.

22. The article of manufacture as claimed in claim 21 further comprising:

code for terminating regeneration and resetting the accumulated NOx to the level of the remaining stored NOx in the lean NOx trap when a regeneration ending event is reached.

23. The article of manufacture as claimed in claim 22 wherein said regeneration ending event is selected from the group consisting of rich deviation of gases flowing out of the NOx trap, expiration of a regeneration timer, and engine torque demand below a threshold value.

24. The article of manufacture as claimed in claim 20 wherein regenerating the NOx trap is caused to occur as a function of the accumulated NOx emissions in the NOx trap.

25. The article of manufacture as claimed in claim 24 further comprising:

code for terminating regeneration and resetting the accumulated NOx to the level of the remaining stored NOx in the lean NOx trap when a regeneration ending event is reached.

26. The article of manufacture as claimed in claim 25 wherein said regeneration ending event is selected from the group consisting of rich deviation of gases flowing out of the NOx trap, expiration of a regeneration timer, and engine torque demand below a threshold value.